# Toward Scenario Adaptation for Learning

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**Abstract.** This paper presents a methodology for automatically customizing a scenario to suit a learner's abilities, needs, or goals. Training scenarios are often utilized to give learners hands-on experience with real-life problem solving tasks. The customization of scenarios has the potential to improve learning gains within these domains. We present initial steps toward an intelligent technology called a Scenario Adaptor that employs a partial order planning formalism to reason about learning objectives and causality, and we discuss how the Scenario Adaptor may add or delete learning objectives from a scenario.

## 1. Introduction

Training scenarios - especially those utilized by military, intelligence analysts, and emergency responders - are often utilized to give learners hands-on experience with real-life problem solving tasks. Learners are presented with a simulated course of events and given the opportunity to assess the situation and act to achieve the goals of the scenario. Because the scenario is simulated, errors can be addressed immediately by an instructor or automated system and there are few repercussions for failure. Hence, training scenarios are ideal for task domains where actual failure can be dangerous or costly. Training scenarios are often authored by domain experts or professionals working with domain experts. Not only must the scenario present an accurate picture of the task domain, it must also give the learner opportunities to practice the important learning objectives. Because of these constraints, scenarios can be difficult and time consuming to author and implement, and the result is often a small set of one-size-fits-all scenarios. However, such scenarios may not adequately address a particular learner's abilities, needs, or goals. It may force the learner to practice concepts with which he is already quite familiar and ignore concepts which require more practice.

The work described here takes initial steps toward an intelligent system called a *Scenario Adaptor* that automatically customizes a scenario to suit a learner's abilities, needs, or goals. Given a profile of a particular learner, the Scenario Adaptor customizes a scenario to allow the learner to practice underdeveloped skills and to avoid the redundancy in areas in which the learner has shown proficiency. We define operations for deleting learning objectives from a scenario and adding learning objectives to a scenario.

## 2. Approach

Our approach to the Scenario Adaptor is based on previous work on narrative generation and interactive narrative systems. Both "narrative" and "scenario" are terms describing

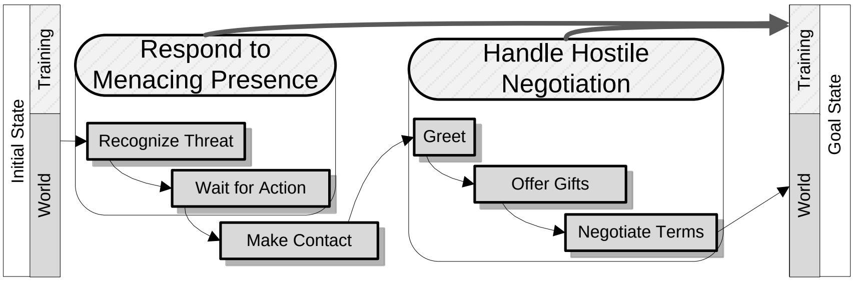


**Figure 1.** A representation of a simple scenario with learning objectives.

sequences of events. A narrative generation system takes high-level specifications about the features that a novel narrative structure should have and other information about the story world and characters, and it creates a new narrative that is distinct from existing narratives. Previous work on narrative generation has explored the use of artificial intelligence planning techniques to create a sequence of events [2]. Planning techniques have the advantage of being able to treat a set of required features for a new narrative as goals, and being able to relate all generated narrative elements back to those goals. An additional benefit to employing planning for scenario customization is the ability to reason about causality. Work in narrative understanding has found that events which are causally related form a more coherent narrative, and are easier to reason about and understand [1]. Scenarios with high degrees of causal relatedness are preferable.

Currently we are employing decompositional partial order planning for representing and reasoning about the scenarios and associated learning objectives [3] (see Figure 1). Steps in the plan represent events in the scenarios and learning objectives. Causal links and decompositions relate steps. Young and Moore [3] provide a more complete description of one such planner.

To represent learning objectives, we split the planning namespace into world state and training state and define abstract learning level steps with effects on the training state. The scenario initial and goal states are augmented with states of the learner before and after the scenario. The decompositions for these learning level steps are defined by the domain author such that experiencing the steps in the decomposition gives the learner the opportunity to practice the learning objective. Figure 1 is an example of a simple scenario with two learning objectives. In this example, the skill of handling a hostile negotiation is decomposed into the concrete steps of greeting, offering gifts, and finally negotiating terms. The step of making contact is not part of a learning objective, but it serves the purposes of transitioning between objectives and increasing causal relatedness, thus improving cohesiveness [1].

Decompositional planning by itself is not sufficient to customized a scenario for a particular learner because it does not promote cohesive causal structure. Therefore, we identify two basic operations to customize a scenario: deletion and addition. To delete a learning objective, the training level step and all steps which belong to its decomposition are removed. This may leave an incomplete plan containing link threats and open preconditions - the scenario may no longer be coherent. Decompositional planning is be performed to complete the plan (cf. [3]). To delete the 'Respond to Menacing Presence' learning objective in the example, the training step and the world state steps 'Recognize Threat' and 'Wait for Action' are removed. The 'Make Contact' step is no longer re-

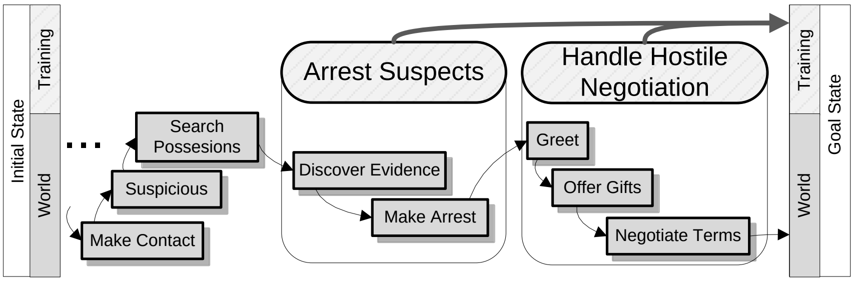


**Figure 2.** Scenario Adapted to include a new learning objective.

quired, and is removed as well. Now, the preconditions of the 'Greet' operator are no longer satisfied, and the planner must find effects or create new steps to complete the plan. The planner may choose a new 'Receive Visitor' event to fill this role, giving the trainee someone with which to negotiate.

To add a learning objective, the learning level step and one of its decompositions are inserted into the plan. The example scenario is adapted in Figure 2 to contain a new learning objective, 'Arrest Suspects'. After insertion, the planner may simply be invoked to satisfy all of the preconditions, however, as noted above, sequences of actions which do not causally contribute to the outcome of the scenario may be viewed as peripheral or pointless [1], possibly lessening the learning opportunity by confusing the learner. The new steps must be included on a causal chain to the goal state. One of the causal links in the plan is replaced by a causal link leading from one of the steps in the new decomposition. The link between 'Make Contact' and 'Greet' is removed, and a new link between 'Make Arrest' and 'Greet' is formed. Then, all steps which are no longer on a causal chain to the goal state are removed. If this process removes steps contributing to other learning level steps, then either new decompositions must be chosen for those learning objectives or the algorithm must backtrack. Finally, decompositional planning is invoked to complete the plan. The planner finds that new 'Suspicious' and 'Search Possessions' steps will give the trainee cause to make the arrest. This process results in a complete scenario that includes the new learning objective such that events that expose it to the learner are causally related to the outcome, keeping the scenario coherent.

The adaptation of scenarios may make more more effective computer-based learning environments by creating more efficient training experiences. The individualization of scenarios has the potential to improve engagement. Trainees may spend less time on tasks that are either too easy or too difficult and more time on tasks that are challenging but within reach. New algorithms are needed to adapt scenarios, and future work will finalize these algorithms and test learning outcomes.

## References

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